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IMPACT TEST ANALYSIS ON PURE AND RECYCLED HDPE

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DEDICATION

Thanks to Allah S.W.T., my parents, my family, siblings and all my friends.

ABSTRACT

Nowadays High Density Polyethylene (HDPE) plastic have been widely used in many industries. Lower cost of the raw material and increased in environmental awareness are defined as the key factor in the use of HDPE plastic in the industries. Characteristic of HDPE plastic themself, such as lightweight, strong, tough, easy to find the supplies of HDPE plastic and easy to mold making it more preferable rather than metal. Although this material has its advantages, but it also has its drawbacks to considered. Time consuming in decaying the HDPE plastic waste will greatly affect the environment and nonetheless to the manufactures as it will also incur additional cost in managing to dispose of the plastic and cause the manufacturer profit affected. Hence, the recycling process is one of the ways to overcome this problem. Mixing the recycled HDPE and pure HDPE with a certain percentage of both material is one of method that mostly widely used methods. In this study, pure HDPE and recycled HDPE were undergoing the mixing process based on the required percentages that has been determined. The specimens were produced using the hot press machine, and the specimen were also tested by the Izod impact test to obtain an optimum percentage. There are three main samples of mixing material in different percentage and each sample has three specimens that has been tested using the Izod impact test. This experiment was conducted based on ASTM D256. The parameter involved in this study are temperature and time. The result showed that the optimization for impact test on pure HDPE was 0.139 ftib/in^2 using the 197.23°C for temperature and 6.41 minute for time, while the yield for recycled HDPE was 0.654 ftib/in^2 using 197.25 °C for temperature and 12.61 minute for time, followed by mixture of pure HDPE and recycled HDPE was 0.167 fib/in^2 using the 193.23°C for temperature and 6.21 minute for time. The output show that the flexural properties are enhanced by increased with the recycled HDPE material. However, the impact strength of the composites decreased as the 100% of recycled HDPE are increased. SEM micrographs revealed good interfacial bonding between pure HDPE and recycled HDPE matrix.

ABSTRAK

Pada masakini, plastik High Density Polyethylene *digunakan secara meluas didalam banyak industri. Kos yang lebih murah untuk bahan mentah dan peningkatan kesedaran alam sekitar yang ditetapkan sebagai factor utama dalam menggunakan plastik* HDPE *didalam industri. Ciri-ciri yang ada didalam* HDPE *itu sendiri seperti ringan, kuat dan mudah untuk pengilang membuatkan ia lebih baik daripada logam. Walaupun bahan ini mempunyai kelebihan, tetapi ia juga mempunyai kelemahan yang perlu dipertimbangkan. Ia akan memakan masa ketika waktu proses pereputan dan* HDPE *plastik akan memberi kesan kepada alam sekitar dan dalam masa yang sama untuk perkilangan kerana ia juga akan melibatkan kos tambahan dalam menguruskan proses melupuskan plastic dan menyebabkan keuntungan pengilang akan terjejas. Oleh itu, proses kitar semula adalah* salah *satu cara untuk mengatasi masalah ini. Mencampurkan* HDPE *yang dikitar semula dan* HDPE *tulen dengan peratusan tertentu kedua-dua bahan adalah salah satu kaedah yang kebanyakkan digunakan. Dalam kajian ini,* HDPE *tulen dan* HDPE *dikitar semula akan menjalani proses pencampuran berdasarkan peratusan yang telah ditentukan. Spesimen akan dihasilkan dengan menggunakan mesin* Hot Press *dan kemudian spesimen akan menjalani ujian hentaman* Izod *untuk menetukan peratusan yang paling optimum. Terdapat 3 sampel utama bahan campuran dalam peratusan yang berbeza dan setiap sampel akan mempunyai 3 spesimen yang akan diuji menggunakan ujian hentaman Izod. Eksperimen ini telah dijalankan dengan mengikuti* ASTM D256. Design of Experiment software *digunakan untuk menentukan hubungan antara faktor yang mempengaruhi keputusan ujian. Data ini diperlukan untuk tujuan pengoptimaan output. Faktor-faktor yang terlibat didalam proses ini adalah suhu dan masa, manakala tindak balasnya adalah hasil ujian hentaman. Keputusan menunjukkan bahawa pengoptimuman ujian impak pada HDPE tulen adalah 0.139 ftib / in² menggunakan 197.23°C untuk suhu dan 6.41 minit untuk masa, manakala hasil untuk HDPE dikitar semula adalah 0.654 ftib / dalam ² menggunakan 197.25 °C untuk suhu dan 12.61 minit untuk masa , diikuti dengan campuran HDPE tulen dan HDPE dikitar semula adalah 0.167 fib / dalam ² menggunakan suhu 193.23 °C untuk suhu dan 6.21 minit untuk masa. Output menunjukkan bahawa ciri-ciri lentur ditingkatkan dengan meningkat dengan bahan HDPE dikitar semula. Walau bagaimanapun, kekuatan kesan komposit menurun apabila 100% HDPE dikitar semula meningkat. Mikrograf SEM mendedahkan ikatan interfasi yang baik antara HDPE tulen dan matriks HDPE dikitar semula.*

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LIST OF ABREVIATIONS

ASTM	- American Society for Testing Materials
HDPE	- High Density Polyethylene
ISO	- International Standard Organization
RHDPE	-Recycled High Density Polyethylene
PHDPE	-Pure High Density Polyethylene
MFI	-Melt Flow Index
SEM	-Scanning Electron Microscopy

CHAPTER 1

INTRODUCTION

1.1 Introduction

High density polyethylene (HDPE) is one of the materials that are most commonly found in bottle milk or jugs, plastic bags and refillable plastic bottles. Moreover, recycled HDPE plastics generally are suitable for manufacture lawn and garden products, and vehicle parts (Reis, 2012).

According to McEvoy (2008), producing plastic has a world environmental effect since it utilizes numerous fuel products. There are about 3 million tons of plastic waste each year are created by people in the world. The government agency report that around 80% of plastic waste is reaching landfill sites. This is a fundamental issue explanation behind land fill district growing and ecological impact. The possible solutions are to reuse or recycles the plastic that has already been produced. In fact, recycling plastic has many benefits such as reducing consumption of energy and nonrenewable fossil fuel use.

Some analyst (Reis, 2012) has attempted to identify that the HDPE plastic has a few properties that make it suitable as a packaging and manufacturing product. It is extremely stronger than existing polyethylene, serves as a very effective against humidity and then remains solid at room temperatures. It resists against rot and other chemical corrosion. It was easily recyclable and can be used for making a new product again. Recycled HDPE creates no harmful extrication during its productions or during its usage by the user or consumer. Also HDPE puncture no toxic chemicals into the ground water.

In addition, because HDPE plastics are composed of organic compounds, the disadvantage is that their decay process takes a quite a while. As it is impossible to avoid plastic consumption, which parallel with the development of new technology, real solution have to be searched for the emerging issues from the developer of plastic used, especially HDPE plastics. That is, recycling techniques and methods for assessing these recycled materials must be found.

In this study, 100% pure HDPE and 100% recycled HDPE and eight (8) mixed combination with different percentage will be observed and their output (specimen) will be analysis through the impact test.

1.2 Problem Statement

High Density Polyethylene (HDPE) is the most widely used resin for plastic bottle, food container and plastic bag. It is because this material is economical, impact resistant and provided a good moisture barrier. HDPE is compatible with a wide range of products including acids and caustics but is not compatible with solvents. HDPE is naturally translucent and flexible. These durable properties make it perfect for heavy duty containers and it does not absorb fluid promptly which is making it good barrier material for liquid containers.

However, recycling of these containers a stream of recycled plastic that profoundly homogeneous and steady. The high volume usage ensures that there are large quantities of post consumer HDPE homopolymer such as milk and juice bottle also for copolymer such as shampoo bottles for recycling (Strong, 2000). The resultant reused has basically indistinguishable substance properties of the virgin HDPE resin since it does not undergo

any appreciable thermal degradation during recycling. HDPE cannot be reused for food containers because recycled HDPE is a homopolymer and does not possess adequate environmental stress crack resistance properties for recycling process (Strong, 2000; Lotfi, 2017).

Therefore, HDPE recycled into product manufactured by injection molding. Nevertheless, HDPE has the most rigid among the three common PE's and has a density ranging from 0.935-0.960g/cm³ (Sttrong, 2000).

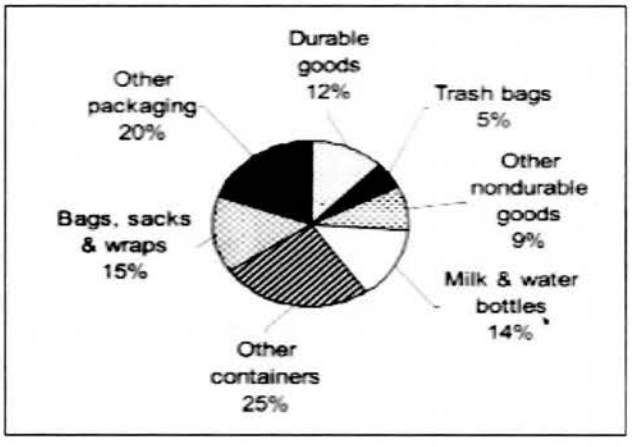

Figure 1.1: HDPE in MSW stream year 2003 (Harper, 2006)

There is increasing concern that for many years, HDPE was the most recycled plastic. According to Harper (2006), stated in years 2003 recycling rates was 31.9 percent HDPE products usually show different failure modes depending on the applied load and environmental condition. The pie chart above shows that the minority of HDPE recycling rate is used for the trash. The study also shows that, the recycling rate for HDPE is only 15 % for bag, sacks and wrap, same average also can be found in food containers.

It is known that the mechanical properties of pure HDPE materials are different from those of the corresponding recycled HDPE materials. However, it is possible to find

an optimum point which can be determined by experimentation which is impact test. Hence, the purpose of this project to study the properties between pure HDPE mixed with the recycled HDPE materials in various proportions on impact strength.

1.3 Objective

In order to fulfil the project aim, the following objectives are proposed:

i. To investigate the performance (Impact Test) of pure HDPE and recycled HDPE material with different percentage contents.

ii. To develop the experimental models for responses (Impact) value of pure HDPE, recycled HDPE and mix HDPE condition.

iii. To determine the optimum condition of pure, recycled and mixed of HDPE.

1.4 Scope

In this research, mostly use the hot press machine at the FKP UTeM laboratory. Other than that, the resin will mix with different percentages of pure HDPE and recycled HDPE resin. Meanwhile, to mix the resin to a fixed amount by using a High Accuracy Electronic Weight Scale were available at FKP laboratory. The properties of the combination between pure HDPE and recycled HDPE will be tested by using the Impact Test machine located at ILP Tangkak. Then the testing will b e conducted by using Standard of America Society (ASTM D256).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter describes about the source and the history of the research that has been done by others that related to this research. The project study will highlight the detail about the process and the testing that might be used to identify the properties in order to carry out an efficient improvement between pure HDPE and recycled HDPE product. The explanation is aided with the literature concept and improvement method implemented by past researchers. The knowledge applied from other expertise literature is significant to produce a valid support for the project study to be referenced for other people in the future.

The literature concept also needs to know about the characteristic and properties of pure HDPE and recycled HDPE materials. It also summarized an impact testing on pure and recycled HDPE. Apart from that, the process of mixing the material need to describe properly includes the ratio between pure HDPE and Recycled HDPE.

2.2 Plastic Polymer

Plastic is a material consisting of any of a wide range of synthetic or semi-synthetic organics that are malleable and can be molded into solid objects of diverse shapes. Plastics are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, but many are partially natural. For this study, both materials selected are high performance